THE CALIFORNIA EARTHQUAKE.

The California Earthquake of 1906. Edited by David Starr Jordan. Pp. xv+371; illustrated. (San Francisco: A. M. Robertson, 1907.)

THIS is a collection of nine well-written essays, which, as might be expected, more or less overlap in their subject-matter. The first of these, by the editor, deals almost entirely with the Great Fault or Rift, the sudden yielding along which caused the earthquake. The strongest motion was felt where the fault enters the sea, near to which hotels and houses were thrown into the water. A fact that there was some disturbance in the sea suggests that a portion of the origin was beneath the same. At one place a train was overturned. We read that persons in an undisturbed district looking towards one that was shaken may have seen rows of trees and rows of bushes filing past them. The earthquake, we learn, was not connected with eruptions in the Aleutian Islands. The author gives us lists of Californian earthquakes, the more destructive of which apparently have had a period of thirty to forty years. He is inclined to ridicule electrical theories as a cause of earthquakes, and in referring to the destruction which took place in town and country, he quotes from the book of Isaiah, which declares that "men shall be plagued by their own inventions."

The second essay is by Prof. Branner. It deals with the geology of the earthquake. He chiefly describes the Great Fault, which split both trees and houses. Prof. Derleth confines his remarks to the effect of the earthquake upon structures. Destructivity is marked along a belt 300 miles in length and fifty miles in breadth. Apparently there was an attempt to tell outsiders that San Francisco had only been visited by a fire, but Prof. Derleth thinks it will do San Francisco and California more good if it is admitted that there really was an earthquake. Santa Rosa, like San Francisco, had fire simultaneously with the earthquake. Varieties of buildings in San Francisco are described in a variety of terms. Some were honest, some dishonest; some were fire-traps, others fire-proof without but not fire-proof within. Destruction varied according to the nature of the ground on which buildings were placed. The failure of water-pipes and sewers is described in great detail. In short, this essay is a treatise on building, for which thirty-nine rules are given. With most of these we quite agree, but not with all. Rule 4 refers to brick chimneys, which, we are told, should be built of weak lime mortar. Built in this way, when the earthquake comes they will crumble and fall as individual bricks, but if built with rich cement they will fall *en bloc*, and crush through the roof. We admire what Prof. Derleth has done off his own bat, which, taken altogether, is certainly good, but we cannot help suggesting that he might with advantage have consulted the results which have been arrived at with regard to construction in countries other than his own.

Mr. G. K. Gilbert, of the U.S. Geological Survey, also describes the Great Fault, seventy-five miles from which the shock was observed by nearly all persons awake, but at 200 miles it was perceived by only a few. Mr. S. Taber, of the Stanford University, estimates the area of greatest damage as being a little more than 200 miles in length and forty miles in width. The intensity of the shock was greatest along the line of faulting, and the initial movement was parallel to the same.

Dr. F. Ōmori, of the Imperial University of Japan, gives us interesting notes with regard to several points not touched upon by other writers. He tells us that in San Francisco the greatest number of monuments were overturned towards the east; the ascertained number of persons killed in San Francisco was 300, while the total number of persons killed in the earthquake area was probably not more than 1000; the double amplitude of motion in San Francisco was about 4 inches, and the period was about 1 second. For twenty or thirty years, Central California may seismically be regarded as a very safe place.

The last article is a personal narration by Mary Austin. It is not intended to be scientific, but it contains sufficient epigram, pathos, and humour to make it well worth reading. The first words are, "there are some fortunes harder to bear once they are done with, than while they are doing." Later we read, "It is perfectly safe to believe anything anyone tells you of personal adventure; the inventive faculty does not exist which can outdo actuality." Speaking of intelligence that reads God behind seismic disturbance, the writer says that the actual damage done by God to San Francisco was small beside the damage that resides in man's contrivances. Man made things carry the elements of their own destruction.

J. MILNE.

ELECTRIC RAILWAYS.

Electric Railways Theoretically and Practically Treated. Vol. ii., Engineering Preliminaries and Direct-current Substations. By Sydney W. Ashe. Pp. vi+282. (New York: D. Van Nostrand Co.; London: A. Constable and Co., Ltd., 1907.) Price 10*s.* 6*d.* net.

THIS is essentially a book for experts, and especially American experts. The English engineer may find here and there in the book some information that will be useful, but he must be an expert to understand it. On the title-page we read that this is "Volume Two," and that it deals with "Engineering Preliminaries and Direct-current Substations." By preliminaries the author means statistics as to the relations between the number of inhabitants in a town and their requirements in the way of travelling facilities.

The amount of statistical material brought together in the first few pages is very large, but as it refers exclusively to American towns it is almost useless to the European expert. The condition of the public roads, the scarcity of cabs, the hustling tendency of the business man, and the general tendency to ride rather than walk, all make for a greater development of travel facilities by tramway than on this side of the Atlantic, so that the figures given by the author

would have to be used with great caution in estimating tramway requirements in Europe. Fortunately there is no need to use American figures at all, since sufficient data are available from European experience. A curve on p. 14 is interesting as showing that with the expansion of towns the mileage of electric lines per 1000 inhabitants goes down, and the yearly number of journeys made by each inhabitant goes up. The figures are not directly applicable to European towns, but the tendency shown by these curves is the same in Europe. Towns of about 40,000 inhabitants show the greatest mileage, namely 0·76 per 1000 inhabitants, but only 110 journeys per inhabitant yearly, whilst towns of one million inhabitants and above have on the average only half a mile of line per 1000, but each inhabitant uses the cars on an average 230 times a year.

It is not clear from the author's figures whether they refer to what we should term tramways or whether they include railways also; the latter is probable, for tables giving mileage, equipment, cost, and earning of electrified main lines are mixed up with the other statistics. The next three chapters are devoted to what the author calls "Electrical Features," and deal with motor capacity and running diagrams. Various methods for getting out these curves are given, namely, Armstrong's, Storer's, and Hutchinson's methods, the latter at some length. The treatment is by no means lucid, formulæ and coefficients being introduced without explanation. Unless the reader is a thorough expert in this subject (when he needs no further instruction from the author) he will make nothing of these chapters.

Altogether the author's mathematics is not characterised by exactitude. Thus, on a later page, when he treats of converters, following (with due acknowledgment) Mr. Hay's method for the determination of the output, we find him calling a line like the following

$$\tfrac{1}{4}I_d^2+\tfrac{1}{2}I_a^2-\tfrac{1}{2}I_a\int_0^{\pi}\cos 2\left(\alpha-\frac{\pi}{n}\right)\pm I_dI_a\int_0^{\pi}\sin\left(\alpha-\frac{\pi}{n}\right)$$

an equation, without saying what it is equal to, and omitting the differential $d\alpha$. It will also be noticed that the third term should contain either the product of two currents or the square of a current, so that the expression is also wrong in the matter of dimension. A reader having Mr. Hay's book at hand will perhaps be able to find his way through the author's mathematics, but without such aid he had better skip the part on p. 195.

The author seems to pin his faith to the system, almost universal in America, of transmitting by three-phase current and converting into continuous current by means of rotary converters in substations. Motor generators, direct working, or the use of boosting batteries are not even mentioned. The important matter of heating of transformers and means of cooling is dealt with in less than two pages of general remarks, but to make up for this we get plenty of catalogue pictures of plant installed by the two leading American companies. Chapter ix., treating of insulating oils, is instructive. On p. 234 a curve is given showing the enormous influence on the insulating property of the oil of even slight traces of moisture, and the specification given on p. 239 should prove useful. GISBERT KAPP.

OUR BOOK SHELF.

(1) *Algebraic Equations.* By G. B. Mathews, F.R.S. Pp. viii+64. (2) *The Theory of Optical Instruments.* By E. T. Whittaker. Pp. viii+72. Cambridge Mathematical Tracts, Nos. 6 and 7. (Cambridge: The University Press, 1907.) Price 2*s.* 6*d.* each net.

(1) THE solution of a given equation is a problem which has attracted the attention of many of the greatest mathematicians. In this tract we have a short summary of the results arrived at. The solution depends on the properties of a certain permutation-group called the Galoisian group; if this group is soluble, the equation is solvable by radicals. Interesting types of soluble groups are cyclical, Abelian, and metacyclic groups. To each of the corresponding equations is devoted a chapter in which are explained the application of cyclical groups to cyclotomy, the dependence of Abelian on cyclical equations, and Kronecker's solution of the metacyclic equation. Prof. Mathews's masterly epitome of the subject is not very easy reading, and he assumes some knowledge of Tschirnhausen's transformation, the theory of permutation-groups, &c. The student will probably have to prepare himself for the study of this tract by reading some more elementary treatise on the same subject (*e.g.* Dickson's "Algebraic Equations"), and some book on groups, such as Burnside's.

(2) Dr. Whittaker does not follow Prof. Mathews in writing for the advanced mathematician, but appeals in the first place to those students of physics to whom mathematics is interesting chiefly for its applications. The professed object is to give "a simple theoretical account of those defects of performance of optical instruments to which the names of coma, curvature of field, astigmatism, distortion, secondary spectrum, want of resolving power, &c., are given." Limitations of space necessitate in places proofs which, though clear, are rather too concise; but except for this the beginner will find the tract fairly straightforward reading. The author has succeeded in producing a book which will prove remarkably interesting, not only to the user of optical instruments, but also to any student of mathematics. The leading principles and results are very attractively presented, and can be readily grasped without plodding through every detail of the somewhat laborious approximations which the subject at times requires. H. H.

Detection of the Common Food Adulterants. By E. M. Bruce. Pp. vii+84. (London: A. Constable and Co., Ltd., 1907.) Price 5*s.* net.

THE United States used popularly to be looked upon as *par excellence* the land of wooden nutmegs and similar examples of perverted manufacturing ingenuity. Perhaps, therefore, it is fitting that what our author calls "the great pure food reform" should find especial favour there. Be that as it may, there has undoubtedly arisen in the States a quickening of interest in the matter of food adulteration; wherefore Mr. Bruce speaks of health officers, food inspectors, chemistry teachers, and even students being constantly called upon to test the purity of various foods —at whose instance is not quite clear. He proposes to help them and others in this task, which he says